Peculiarities of imaging investigations and radiological anatomy in children

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Key points

- To know the peculiarities of performing imaging investigations in children and newborns.
- To know the normal anatomical peculiarities of children in imaging investigations.
- To formulate indications / contraindications of imaging investigations in children.
- Be able to integrate the knowledge obtained in other clinical disciplines.

Indications of the radiological examination

- Attestation of the cause of breathing deterioration.
- Attestation and confirmation of the placement of the tubes and lines.
- Appreciation of mediastinal organs.
- Noting lesions in case of trauma.
- Skeleton analysis:
    - Fractures
    - Lytic or blast pathologies
    - Metabolic bone pathologies
    - Developmental anomalies

- **What are the prerequisites for having a X-ray done?**

A signed request from a referring clinician with appropriate and relevant clinical details.

- **What are the absolute contraindications for X-ray?**

None. A plain X-ray is a low-dose examination. The small risk must be weighed up against the benefit.

- **What are the relative contraindications for X-ray?**

Pregnancy or weight of patient (X-ray tables have weight limits).

- **What are the adverse effects of plain radiography?**

No short-term effects. Generally speaking, the benefit of the X-ray procedure is far more important than the small estimated risk. At the dose levels that are utilised in diagnostic radiography, there is little or no evidence of health effects.

- **Are there alternative imaging tests, interventions or surgical procedures to a plain radiograph/X-ray?**

Ultrasound and MRI do not use radiation, and therefore might be considered as alternatives if diagnostically appropriate. Radiologists have expert knowledge of which imaging test is best suited to answer a clinical question. *For example, an ultrasound might be a better test than an X-ray to locate a non-metallic foreign body in the foot.*

USG

- Screening method
- Affordable price.
- Wide spread.
- It is not based on ionizing radiation.

Categories and varieties:

Neurosonography

Echocardiography

USG of the abdominal organs

USG of kidneys

Genital organs ultrasound

Ultrasound fo thyroid gland

Ultrasound of articulations

Computed Tomography (CT)

- is a useful and accurate cross-sectional imaging test ideally suited for investigating possible pathology in body cavities where the organs of interest may not be accessible to superficial imaging techniques (e.g. ultrasound). These cavities include the skull, thorax, abdomen and pelvis.
- CT is a good examination in a variety of conditions including:

✓acute head injury;

✓suspected subarachnoid hemorrhage;

✓ureteric calculus;

✓acute spine trauma where there is a higher than average likelihood of fracture or dislocation;

✓suspected acute appendicitis;

- It has excellent capabilities to differentiate various soft tissue structures, and can provide excellent bone detail. Compared to other cross-sectional techniques, such as magnetic resonance imaging, it can be done so rapidly that it is minimally affected by patient movement.

What are the relative contraindications for computed tomography?

- All scanners will have weight limits that are specified by the manufacturers. Despite these weight recommendations, there may be limitations to the patient's size. The gantry of the scanner is a fixed diameter and if the patient cannot fit through the gantry, the scan cannot be carried out. A common diameter is approximately 70 cm.

What are the absolute contraindications for a computed tomography?

- Because of the relatively high radiation dose involved in CT scans, it is important to avoid scanning patients who are pregnant, particularly in the first trimester. Radiation exposure to a foetus can cause developmental problems.
- Patients who have a known allergy to the intravenous contrast media (IVCM) used in CT scans should not be referred for scans where IVCM is required to attain a diagnosis. These tests include CT angiograms, and most abdominal and chest scans. If there are no other imaging alternatives, it may be possible to do scans in patients with minor allergies.
- Renal impairment may also prohibit your patient from having IVCM. You should check the patient's creatinine and estimated glomerular filtration rate before referralHyperthyroidism or goitre may be a contraindication to the use of IVCM, as it can induce thyrotoxic crisis in these patients.
- Patients with phaeochromocytoma may experience a hypertensive crisis if intravenous contrast is administered, so if this is suspected clinically and biochemically, a non-contrast scan is prudent.
- Patients with myasthenia gravis have a small increased risk of worsening of their myasthenia, including respiratory muscular weakness, when iodinated contrast is administered, and thus contrast should be used with caution and patients with myasthenia monitored after contrast administration.

- **What are the adverse effects of computed tomography?**

There are two components of CT scanning that have potential risks. These are the radiation dose involved in scanning and the use of IVCM.

- When using radiation for any type of examination, radiographers adhere to the ALARA (As Low As Reasonably Achievable) Principle. This results in the lowest dose possible to acquire diagnostic images.
- Intravenous iodinated contrast media are generally safe, but can be associated with:

✓mild, moderate or severe (anaphylactic) allergic reaction;

✓contrast-induced renal impairment in susceptible people;

✓worsening of thyrotoxicosis;

✓the need for special precautions in some patients with diabetes taking metformin.

MRI

- It does not expose patient to ionizing radiation.
- It allows brain scanning without the need to introduce contrast substances.
- It allows to exam the liver, bile ducts and urination without contrast.
- It provides detailed information about cartilage and muscle structure.
- It is a slow scanning method – patients must be sedated or immobilized.

Absolute contraindications for MRI

- Metal-containing implants as they might heat or move during the procedure. The functioning of mechanical or electronic implants might be interrupted or permanently altered.
- Devices or metal foreign bodies that are most likely absolute contraindications include:

✓ Pacemaker, defibrillator or wires other than sternal wires.

✓ Metallic foreign body in the eye.

✓ Deep brain stimulator – possible thermal injury along the wires, malfunction of device.

✓ Pulmonary artery catheter.

✓ Bullets or gunshot pellets – near great vessels or vital organs, such as the lungs, heart or brain, which might move because of insufficient adjacent scar/tissue and cause damage.

✓ Cerebral aneurysm clips – if magnetic, can move.

✓ Cochlear implant – malfunction.

✓ Magnetic dental implants – loss of magnetic hold to keep the implant in place.

✓ Drug infusion devices – might malfunction.

Relative contraindications for MRI

- There are a multitude of implants within patients that need to be assessed as safe for example: *AAA stent, stapes implant, neuro or bone growth stimulator, surgical clips, wire sutures, screws or mesh,ocular prosthesis, penile prosthesis, joint replacement or prosthesis,other implants and mechanical devices.*

- Large patients might find it difficult to fit into the bore of the MRI. Some MRI facilities have wider bore magnets that can more easily accommodate larger patients.

- Claustrophobic patients might require sedation.

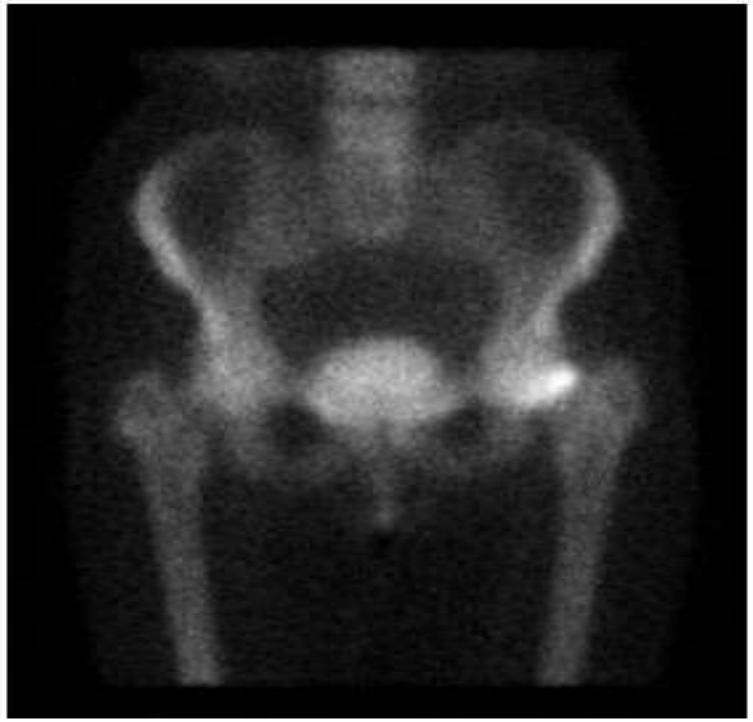
- Significant pain might limit a patient's ability to lie still. Movement degrades the images, limiting interpretation and reducing the accuracy of the report.

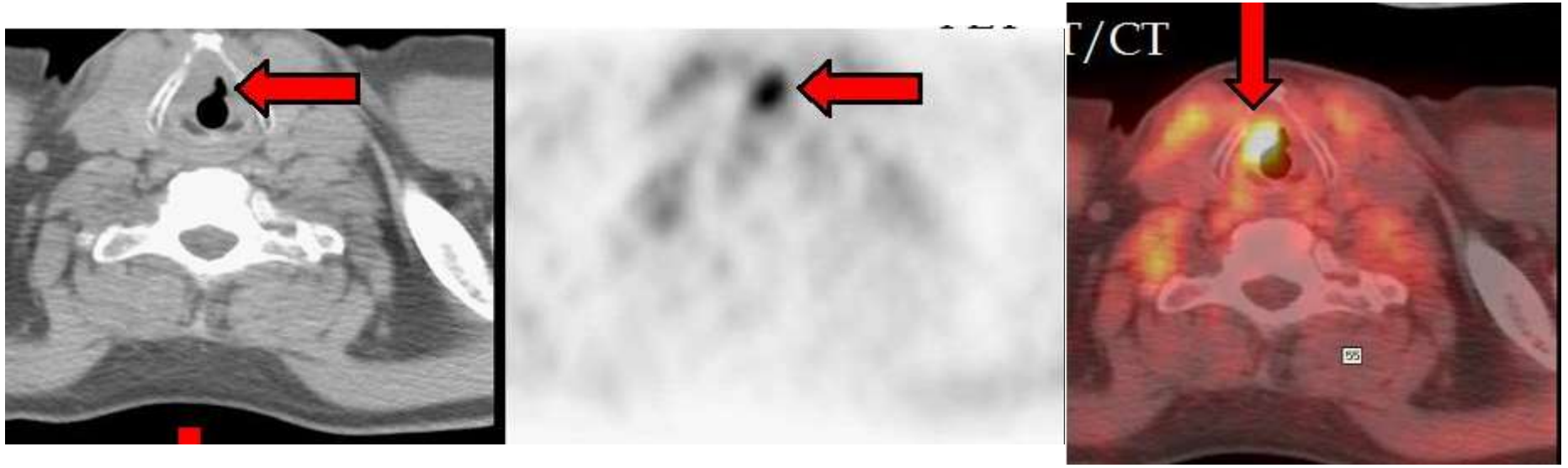
- Surgery in the previous 6 weeks.

- Children can be scanned without sedation from about the age of 6 or 7 years.

SPET/CT and Scintigraphy

- Rad Used in Pediatric Practice
- PET-CT in the diagnosis of oncological pathology (neuroblastoma, sarcoma, lymphoma)
- Bone scintigraphy - of choice in ostomelitis.





SPECT bone scan showing left femoral neck fracture

Larynx cancer demonstration and imaging with PET and CT images combination

- Methods of examination according to the region under investigation

Clinical applications

Skull/Brain

Radiography – for examination in case of fractures that interes skull and facial skeleton.

Ultrasonography is the method of choice and screening for visualization of vessels, ventricles by the fontanel. Accessible for a limited time until the fontanels are closed. No irradiation.

CT - method reserved in the case of craniocerebral traumas and in the case of application of ventricle-peritonal shunts. Contrasting is required to visualize the vessels. Short investigation time. Method of investigation on the basis of X-ray emission. Possibly necessary patient sedation.

MRI – **the best exam method for brain**, does not require contrasting to visualize the vessels. Long investigation time. No X-rays emisions. Certainly necessary sedation of the patient.

The Chest

Radiography – the most often applied method and the simplest. Difficulties are encountered in achieving a suitable inspiration at low age and frequently dynamic blur artifacts.

USG- allows the evaluation of pleural sinuses.

CT scan – provides remarkable information about bone and vascular structures. With the application of contrast and short scanning times possible examination of the heart.

MRI – provides the opportunity to distinguish fatty tissues, vascular and soft structures. Allows the appreciation of mediastinal volume formations. The new applications also allow the functional evaluation of the lungs.

PET/ CT – is used in oncological studies.

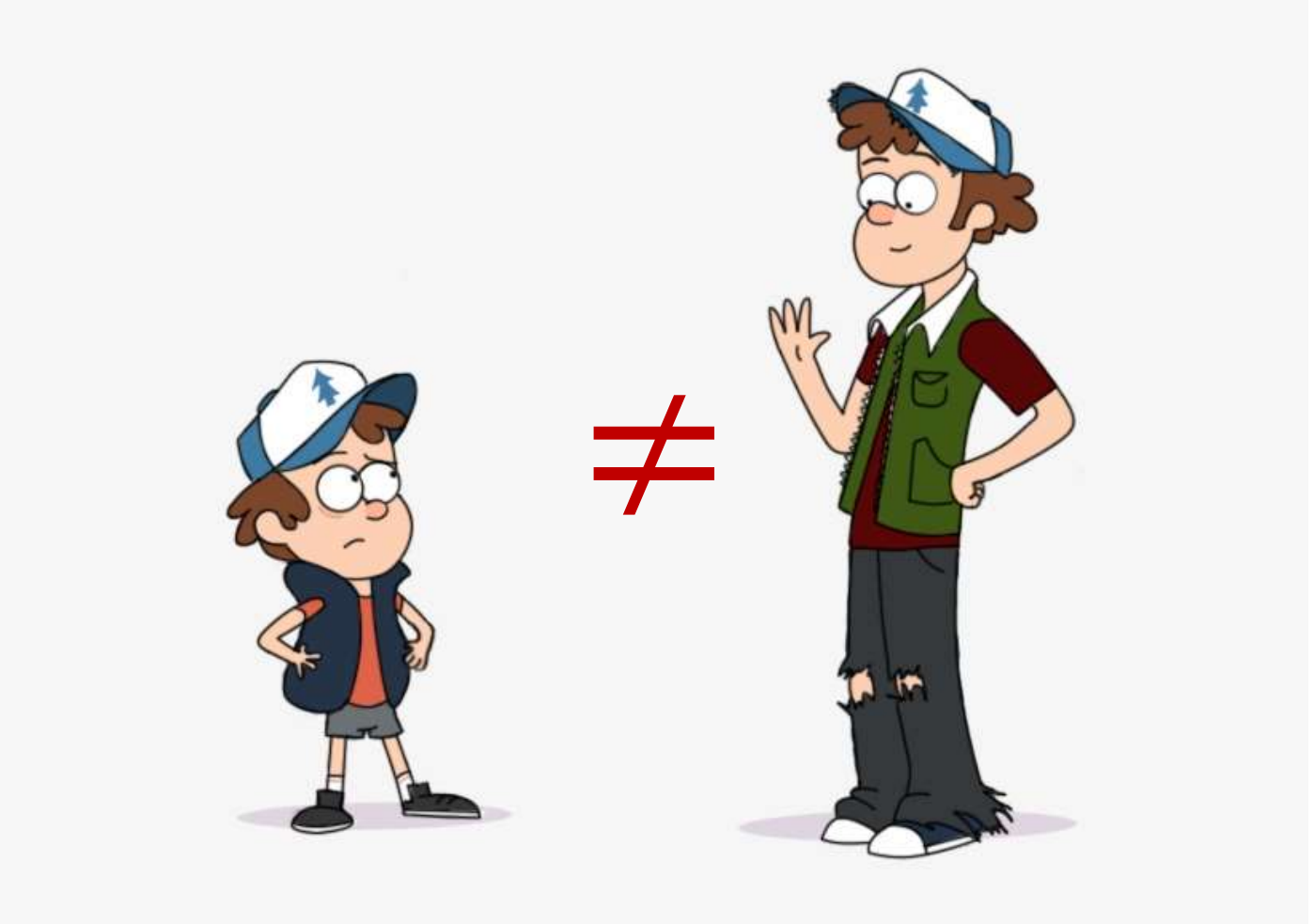
The abdomen

- Radiography is the simplest method in the examination of the acute abdomen caused by intestinal occlusion, perforation of a cavitary organ.
- Fluoroscopia is prohibited in medical practice of pediatric in the Republic of Moldova. In general, it allows functional evaluation of the passage with contrast (barium) . The most known as Upper gastrointestinal tract radiography and Lower gastrointestinal radiographic series.
- USG – the most applied method, is the starting method of examination of the liver, spleen, pancreas and kidneys. It allows to detect the intra-abdominal volume and localization and origin of the processes. Used in the confirmation of intestinal obstruction and the possible detection of the cause (such as invagination). Important in detecting appendicitis or ovarian torsion or hemorrhagic cysts with a fairly high specificity.
- CT scan – provides information about vascular structures. The condition of the internal organs post fall trauma or accidents with high impact power. Pre / post operative examination in oncology.
- MRI – allows to examine the pathologies of the abdominal and small pelvis, allows to visualize the bile ducts, pancreas, as well as the intra and extraluminal formations of the intestines. MRI urography allows anatomical and functional evaluation of the urinary system.
- PET/ CT – is used in oncological studies.

Skeleton

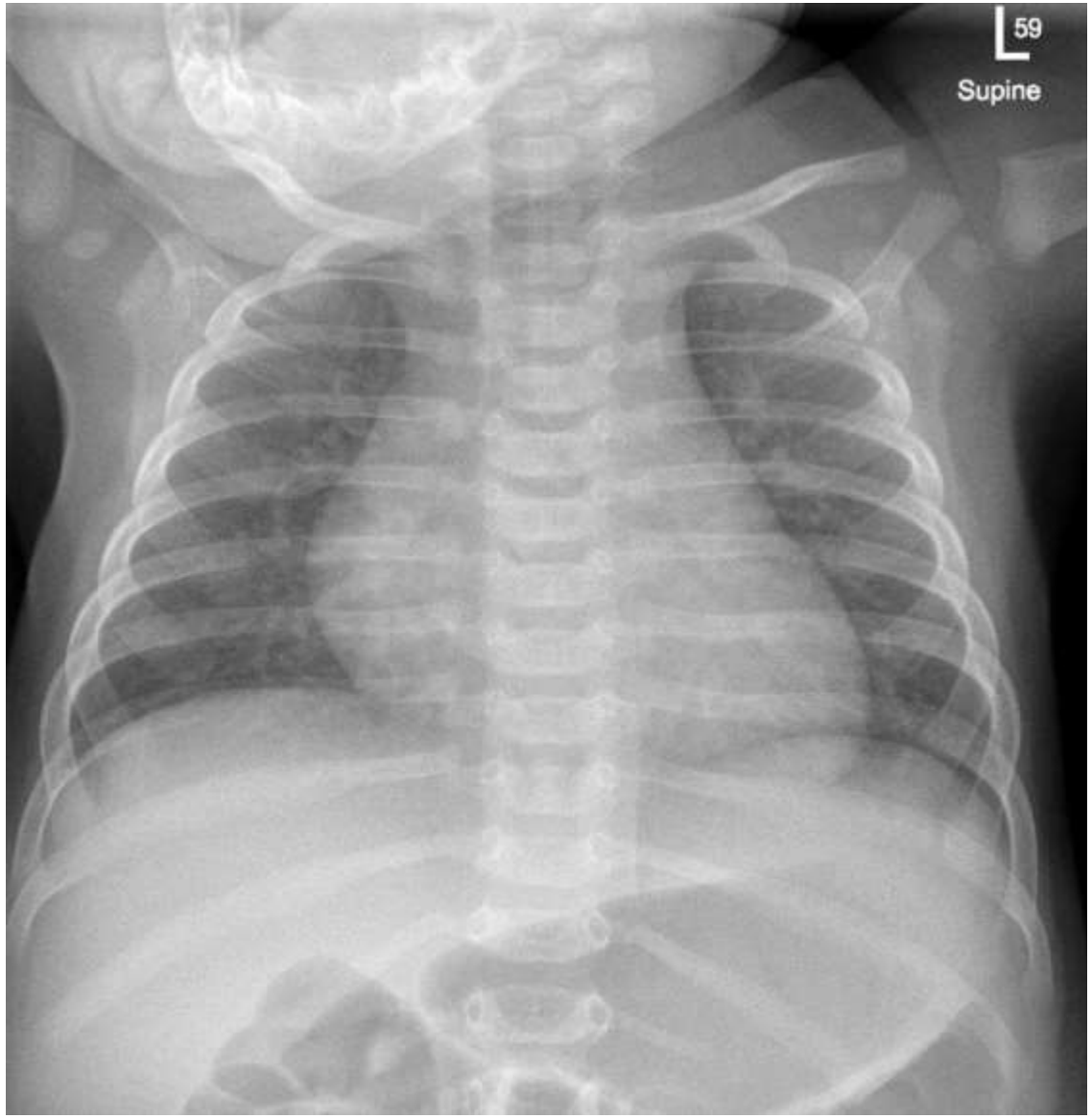
- Flat radiography- is the gold standard in case of trauma, diplasia and the diagnosis of bone tumors.
- CT scan – Examination of difficult traumas, cominutive fractures, fractures of the cranial base, or of the spine.
- Bone scintigraphy – it is used in the examination of bone structures and soft tissues – and can help in the diagnosis of occult pathologies that do not show radiological changes that are related to trauma, tumors or inflammation.

Normal anatomical peculiarities in children and newborns

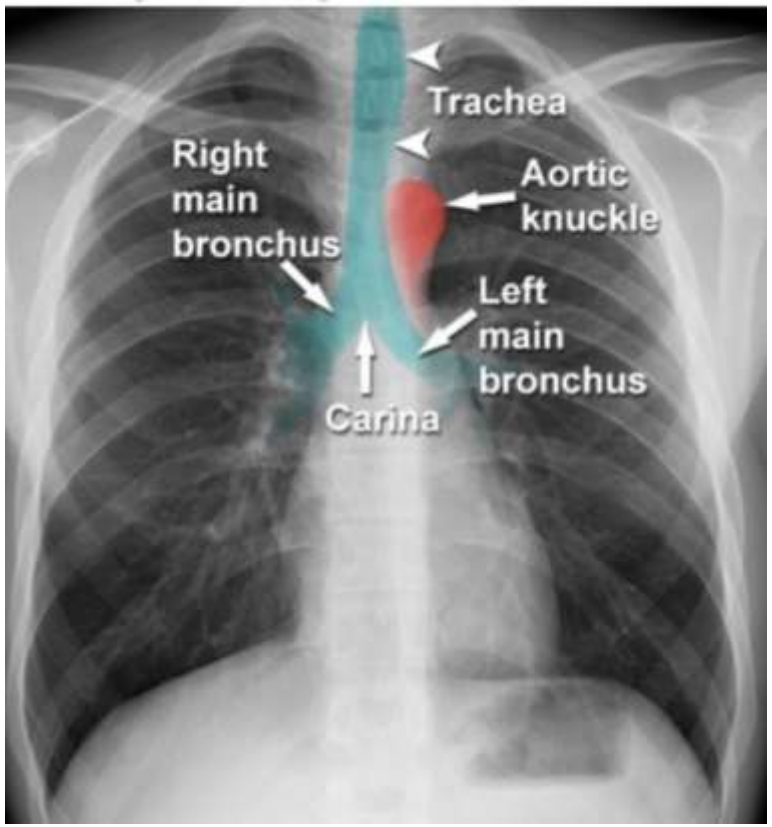


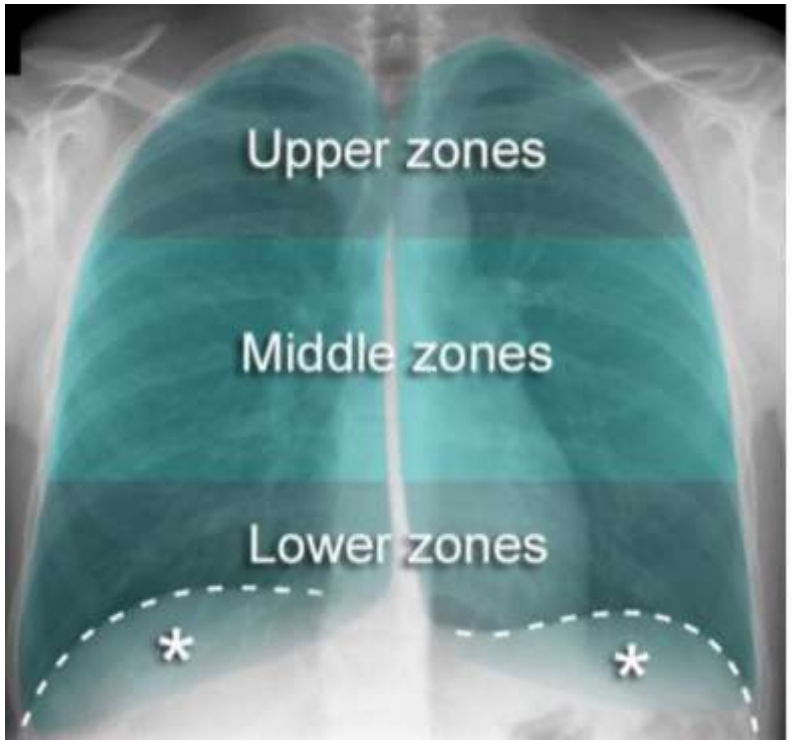
The Chest

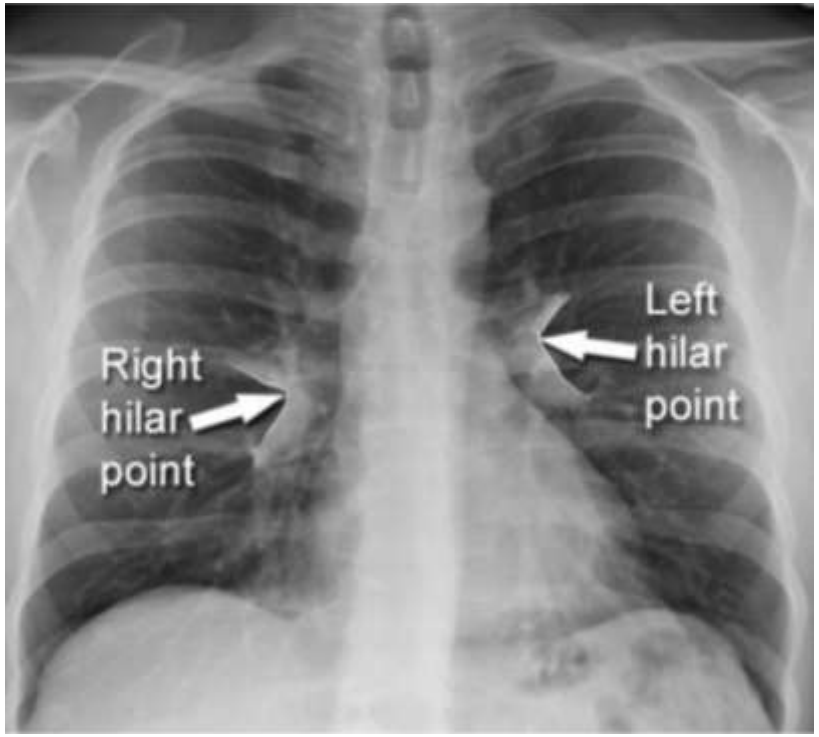
- Cylindrical shape of the chest up to 1 year.
- Ribs horizontalized up to 1 year.
- The cord is horizontalized up to 5 years.
- Trachea diverted to the right up to 5 years.
- The thymus is visible up to 3 years is accepted and up to 7 years.
- The position of the dome diaphragms intersecting the ribs 6-8.



Step-by-step approach and description







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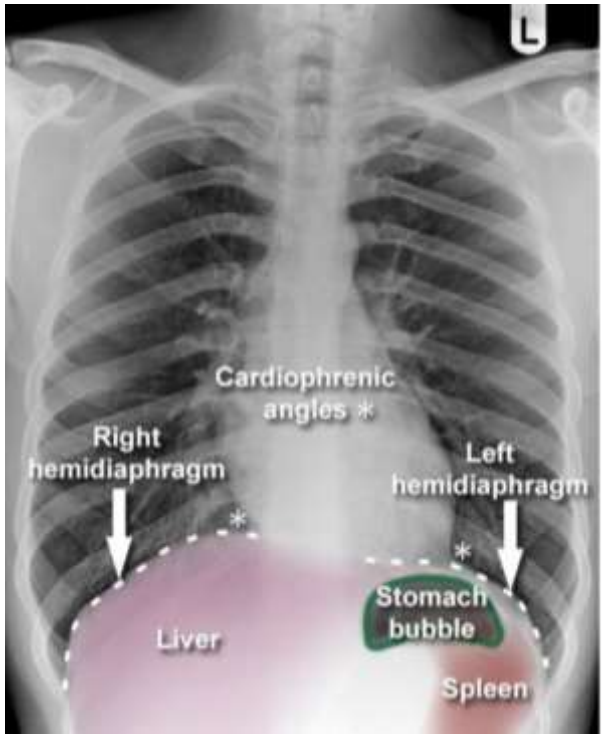
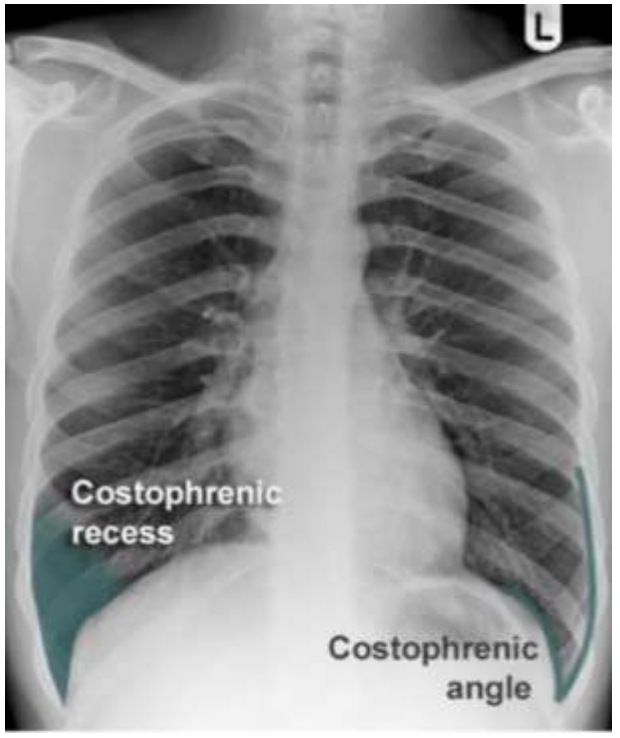
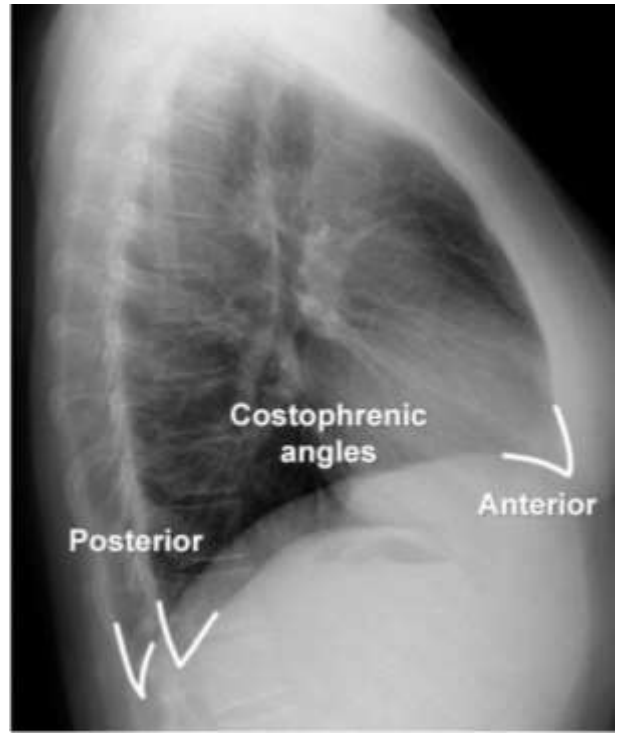
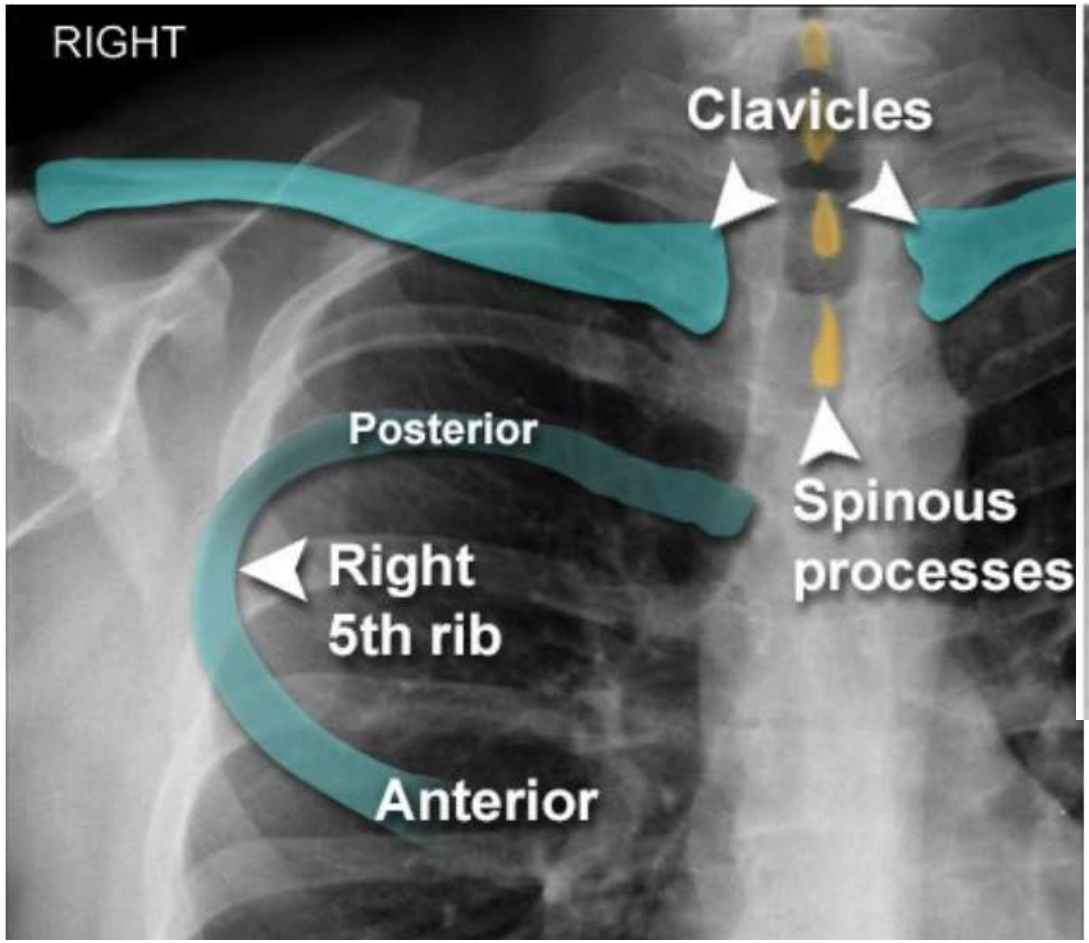
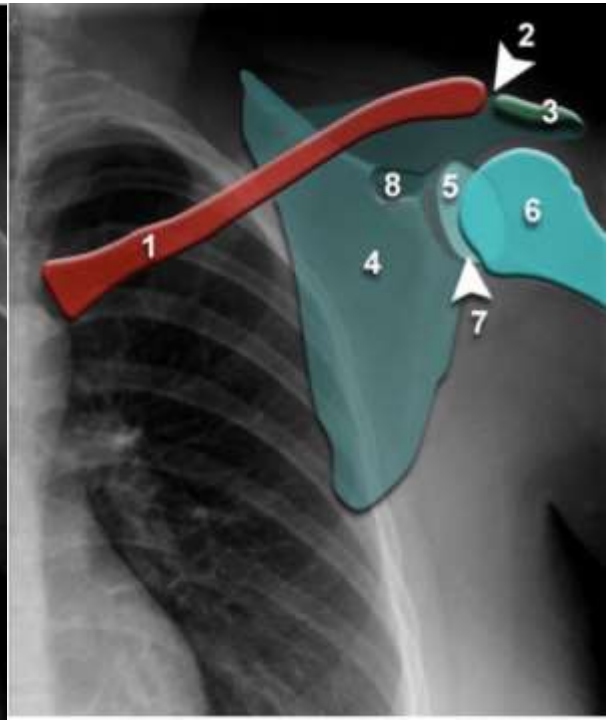






Do not miss bones



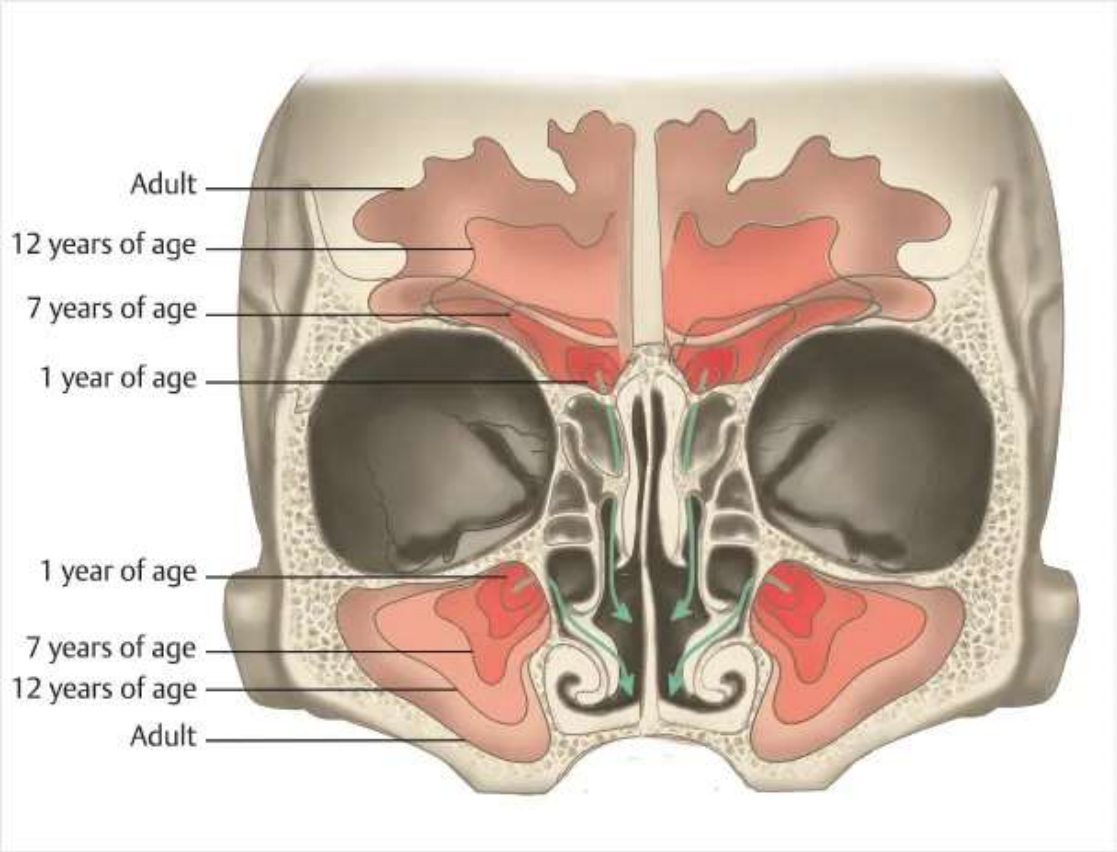


Paranasal sinuses

At birth it is formed:

Maxillary sinus (they are developed symmetrically).

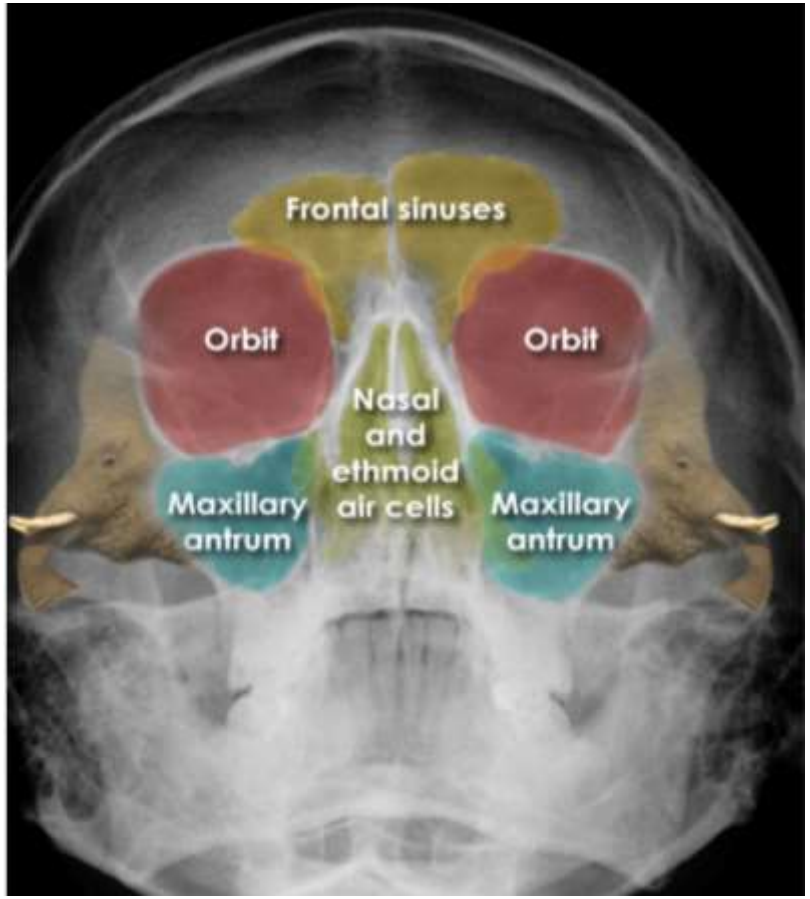
Ethmoid cells.



Post natal develops:

The frontal sinus appears at 6-8 years.

The sphenoidal sinus occurs at 3-5 years.



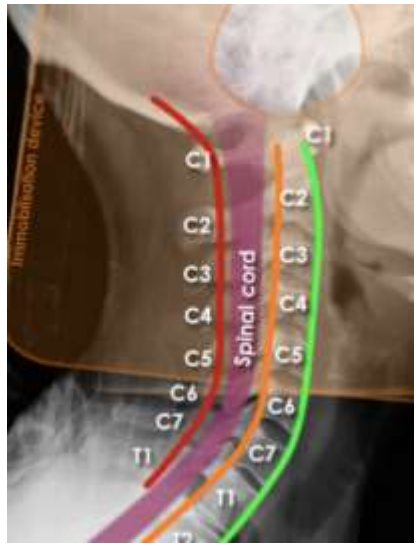
Spine

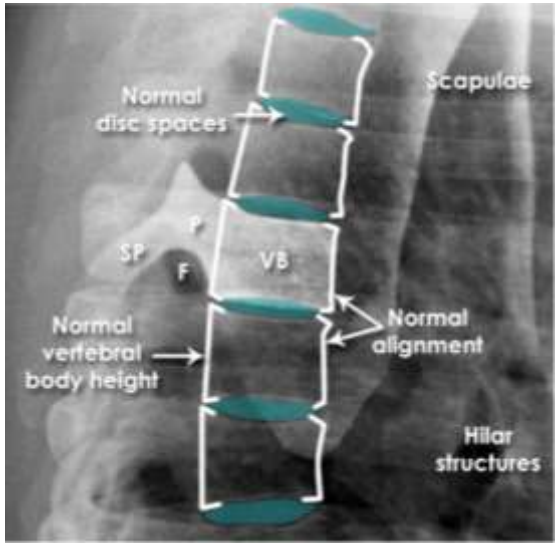
The vertebral bodies have convex shape at birth and are ossified in a proportion of 70%, at the age of 2 years they are ossified 90%.

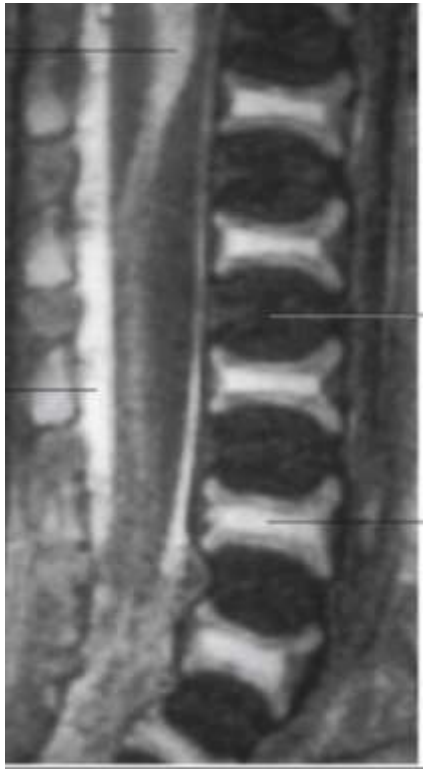
Physiological curvatures occur starting from the 3rd month of life.

The intervertebral space is equal to the height of the vertebral bodies.

The sacral vertebrae do not fuse up to 16 years.







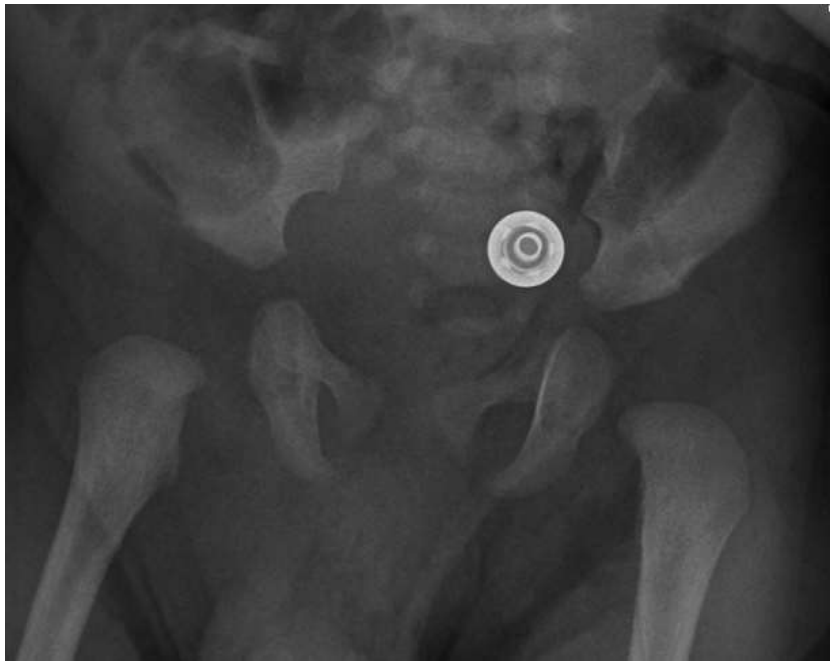
Appearance of the same tubular bone at different ages

They have the growth zone – metaphysis
Contain a reduced amount of minerals and are more flexible.

0,5 1 3 5 8 12 16

Pelvis bones

- Nuceles of ossification of the femoral head are not formed up to 6 months.
- The sacrum in the newborns is located higher than in the mature.



Homework

1. What is radioprotection?

2. Why is it important in pediatric?

3. What are the risks in case of overexposure to ionizing radiation?